

**61500**  
Soil  
749.9 grams

Approaching Flag crater-

LMP: *Boy, anybody that judges Cayley Plains as a flatland. The sides of this thing get pretty steep. I'm not going down too far, I can't see the bottom of it. And it's getting so steep, I don't want to go any farther. - - - I see nothing that looks like bedrock.*

CC: *Ok, how far down from the rim are you?*

LMP: *halfway.*

LMP: *We're going up to where it's more cobbly, Tony, to get a rake sample.*

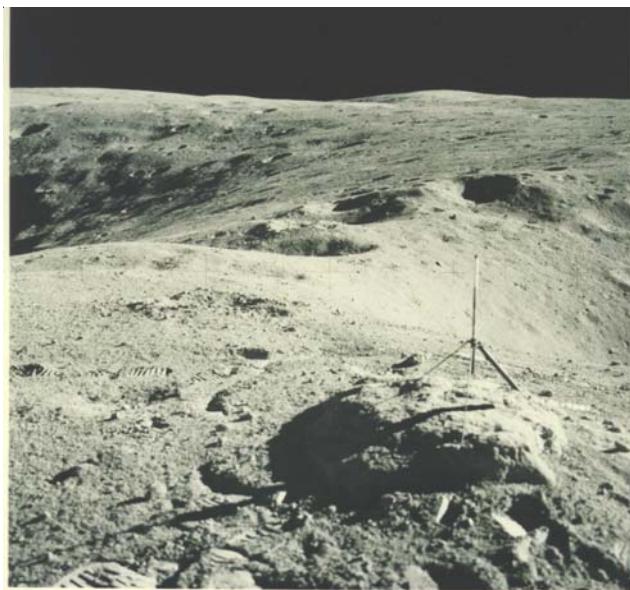


Figure 1: View of ridge between Plum Crater (right) and Flag Crater (left). The sides of Plum Crater were very steep. NASA AS16-114-18420.

## Introduction

Sample 61500 was collected from the rim of Flag Crater (240 m across and 40 m deep), about 1 crater diameter from Plum Crater. It was collected in the same place as the rake sample (61510), from a loose regolith with sparse population of rock fragments.

61500 is part of a set of soil samples (including 61140, 61160) that were to provide ‘radial sampling’ of the ejecta from Plum Crater (Sutton 1981). Plum Crater is on the rim of much larger Flag Crater. Using the overturned flap theory, samples at different distances from Plum Crater would be from different depths in

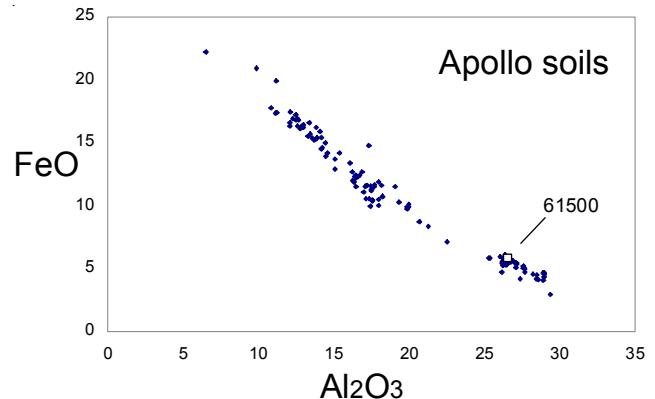


Figure 2: Chemical composition of 61500 compared with other Apollo soils.

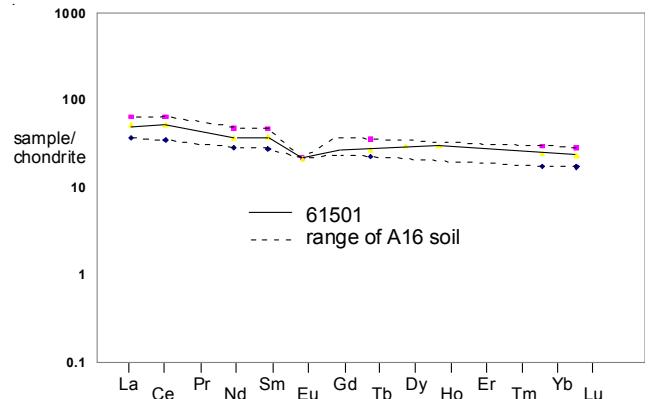


Figure 3: Normalized rare-earth-element diagram comparing 61500 with the range of Apollo 16 soils.

Plum, and thus different depth within the rim deposit of Flag. This, then, would (theoretically) sample the full depth of Flag (40 meters) providing a depth profile through the Cayley Formation.

## Petrography

Soil sample 61500 is submature with  $\text{Is}/\text{FeO} = 53$  (Morris 1978). Butler et al. (1973) and Graf (1993) report the grain size analysis based on sieving (figure 4). No one has reported a modal analysis.

Kempa et al. (1980) calculated that 61501 was made up of ~58 % anorthosite, ~35 % impact melt and 9 % mare component.

## Rake Samples

61500 included one walnut > 1 cm. (61505; 1.65 g), and the adjacent rake sample 61510 included 33 rake samples (tables 2 and 3). Two of these were relatively large (61536; 86 g and 61546; 111 g)(figures 6 and 7). Phinney and Lofgren (1973) described rake samples, while Marvin (1972) described the coarse fine particles from 61500.

## Chemistry

Eldridge et al. (1973), Taylor et al. (1973), Boynton et al. (1975), Wanke et al. (1973) and Scoon (1974) and others reported the chemical composition of 61501 (Table 1). It is typical of Apollo 16 soil (figures 2 and 3) with high Ir content.

Rhodes et al. (1975) found a systematic change in composition of agglutinates as compared with bulk soil. Moore et al. (1973) reported 150 ppm carbon (figure 5). Resse and Thode (1974) reported 589 ppm S.

## Cosmogenic isotopes and exposure ages

Eldridge et al. (1973) determined the cosmic-ray-induced activity of  $^{26}\text{Al}$  = 142 dpm/kg. and  $^{22}\text{Na}$  = 42 dpm/kg.

## Other Studies

Kirsten et al. (1973), Signer et al. (1977) and Etique et al. (1978) reported the rare gas content and isotopic ratios.

Taylor and Epstein (1973) reported isotopic ratios for oxygen and silicon as function of grain size.

Wszolek et al. (1973) found that some of the carbon in 61500 was tied up in the metallic iron (along with other strange results).

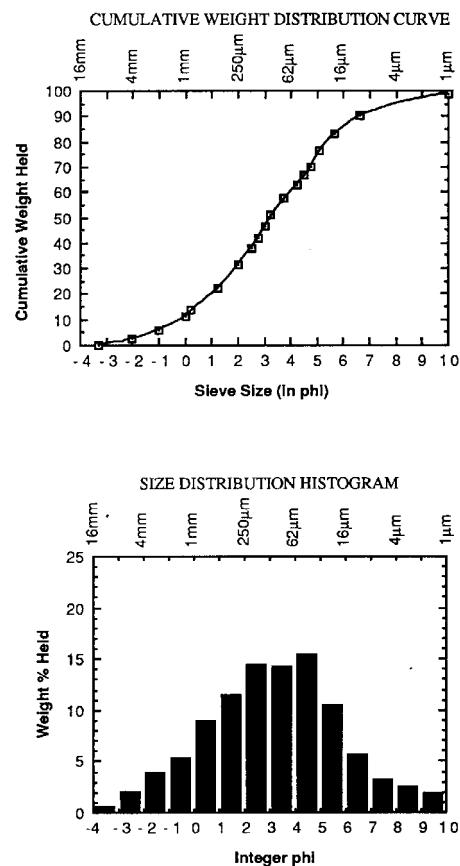


Figure 4: Grain size distribution of soil 61501 (from Graf 1993).

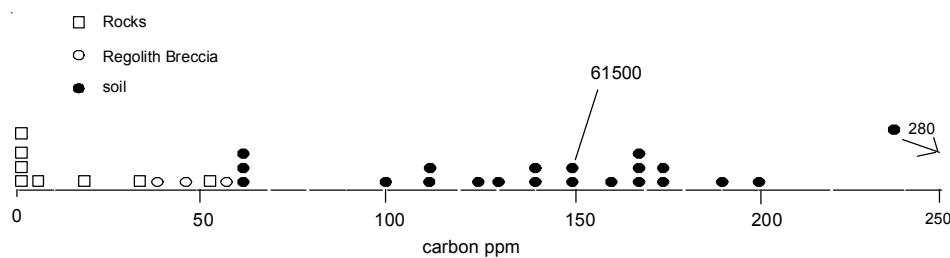
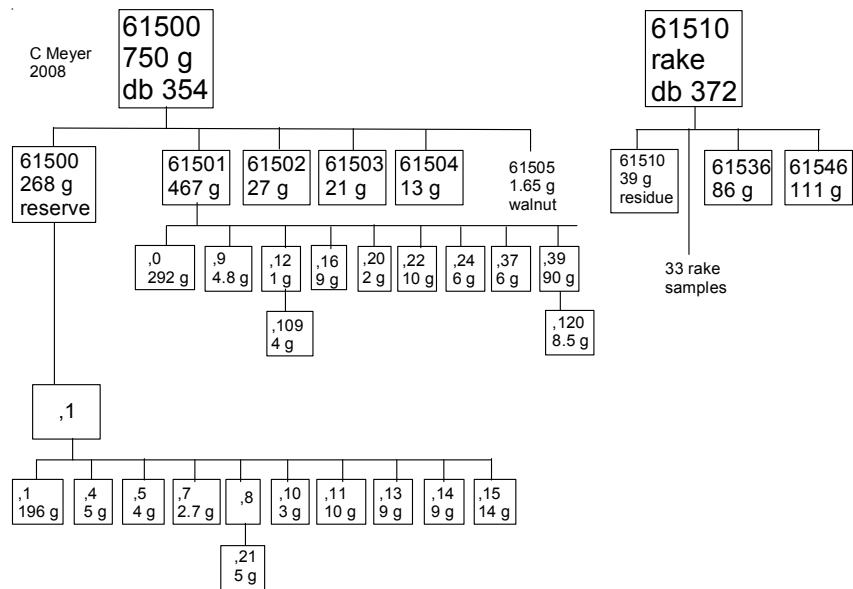


Figure 5: Carbon content of Apollo 16 samples (Moore et al. 1973).



**Table 1. Chemical composition of 61500.**

reference	LSPET72	Eldridge73	Taylor73	Muller75	Boynton75	Wanke73	Scoon74
<i>weight</i>							
SiO <sub>2</sub> %	44.66	(c)	42.2	(d)		45.14	(e) 45.09 (f)
TiO <sub>2</sub>	0.56	(c)	0.47	(d)	0.53	(a) 0.55	(e) 0.57 (f)
Al <sub>2</sub> O <sub>3</sub>	26.5	(c)	27.2	(d) 26.07	26.83	(a) 26.83	(e) 26.78 (f)
FeO	5.31	(c)	5.15	(d) 5.61	5.79	(a) 5.52	(e) 5.59 (f)
MnO	0.07	(c)			0.079	(a) 0.065	(e) 0.06 (f)
MgO	6.08	(c)	6.18	(d) 6.53	6.3	(a) 6.3	(e) 6.17 (f)
CaO	15.33	(c)	15.5	(d) 15.5	15.96	(a) 15.8	(e) 15.31 (f)
Na <sub>2</sub> O	0.41	(c)	0.48	(d) 0.47	0.54	(a) 0.47	(e) 0.48 (f)
K <sub>2</sub> O	0.11	(c)	0.112	(b) 0.23	(d) 0.122		0.106 (e) 0.12 (f)
P <sub>2</sub> O <sub>5</sub>	0.11	(c)					0.13 (f)
S %	0.08	(c)					0.07 (f)
<i>sum</i>							
Sc ppm			11	(d)	19	(a) 8.6	(e)
V			28	(d)			
Cr	760	(c)	750	(d)	740	(a) 690	(e)
Co			39	(d)	35	(a) 29.5	(e)
Ni	256	(c)	390	(d)		470	(e)
Cu			8.5	(d)			
Zn							
Ga							
Ge ppb							
As							
Se							
Rb	3	(c)	2.36	(d) 3.2			
Sr	167	(c)		164		150	(e)
Y	40	(c)	39	(d)		37	(e)
Zr	177	(c)	170	(d)		167	(e)
Nb	11	(c)	12.7	(d)		11	(e)
Mo							
Ru							
Rh							
Pd ppb							
Ag ppb							
Cd ppb							
In ppb							
Sn ppb			0.14	(d)			
Sb ppb							
Te ppb							
Cs ppm			0.12	(d) 0.15			
Ba			170	(d) 141	160	(a) 130	(e)
La			13	(d) 11.8	12.1	(a) 12.2	(e)
Ce			35	(d)	36	(a) 32	(e)
Pr			4.63	(d)			
Nd			18.1	(d)		17	(e)
Sm			5.6	(d)		5.7	(e)
Eu			1.2	(d)	1.22	(a)	
Gd			6.95	(d)			
Tb			1.04	(d)	1.2	(a) 1	(e)
Dy			6.65	(d)	9.1	(a) 7.3	(e)
Ho			1.48	(d)		1.7	(e)
Er			4.2	(d)			
Tm			0.67	(d)			
Yb			4.1	(d)	4.2	(a) 4	(e)
Lu			0.63	(d)	0.69	(a) 0.57	(e)
Hf			3.4	(d)	4.3	(a) 4	(e)
Ta					0.56	(a) 0.48	(e)
W ppb							
Re ppb							
Os ppb							
Ir ppb					14	(e)	
Pt ppb							
Au ppb					9.5	(e)	
Th ppm	2.2	(c) 1.85	(b) 1.82	(d)	2.2	(a) 1.6	(e)
U ppm		0.53	(b) 0.47	(d) 0.5			

technique: (a) INAA, (b) radiation counting, (c) XRF, (d) SSMS, (e) multiple, (f) wet

**Table 2: Rake Samples in 61510 (DB372).**

	weight	Ryder's name	ref
61505	1.65	impact melt	
61515	2 gr.	fragmental polymict breccia	
61516	2.38	fragmental polymict breccia	Floran 76
61517	0.47	fragmental polymict breccia	
61518	0.16	fragmental polymict breccia	
61519	0.33	fragmental polymict breccia	
61525	10.35	polymict breccia, glass matrix	
61526	4.08	fragmental polymict breccia	
61527	0.52	fragmental polymict breccia	
61528	0.24	fragmental polymict breccia	
61529	0.28	fragmental polymict breccia	
61535	0.23	fragmental polymict breccia	
61536	85.99	polymict breccia, glass matrix	
61537	6.62	fragmental polymict breccia	
61538	4.76	fragmental polymict breccia	See 86
61539	5.78	aggregate	
61545	3.61	fragmental polymict breccia	
61546	110.7	glassy impact melt	
61547	17.93	basaltic impact melt	
61548	24.18	glassy impact melt	
61549	3.76	poikilitic impact melt	
61555	3.46	glassy impact melt	
61556	2.23	devitrified glass	
61557	0.93	glassy impact melt	
61558	3	devitrified glass	
61559	0.62	aggregate	
61565	0.88	aggregate	
61566	0.66	glassy impact melt	
61567	0.19	glassy impact melt	
61568	19.32	poikilitic impact melt	
61569	12.02	poikilitic impact melt	
61575	5.26	glassy impact melt	
61576	5.87	plagioclase	See 86
61577	0.21	anorthosite	
61510	38.88	residue	



Figure 6: Photo of 61536 with white clast. Cube is 1 cm. S72-43398.



Figure 7: Photo of 61546. NASA S72-43422. Cube is 1 cm.

**Table 3. Chemical composition of rake samples.**

	61516	61525	61538	61569	61576	
reference	Blanchard, unpublished				Morris 86	
weight	Floran 76	Floran 76	See 86		See 86	
SiO <sub>2</sub> %	45.58	45.85	44.68		44.77	(b)
TiO <sub>2</sub>	0.42	0.55	0.57	1	0.17	(b)
Al <sub>2</sub> O <sub>3</sub>	27.24	26.19	26.65	21.9	31.28	(b)
FeO	4.61	5.27	5.26	7.4	2.75	(b)
MnO				0.09		(b)
MgO	6.05	5.57	6.36	10	3.45	(b)
CaO	15.35	15.12	15.24	12.9	17.34	(b)
Na <sub>2</sub> O	0.54	0.59	0.38	0.467	0.35	(b)
K <sub>2</sub> O	0.12	0.23	0.1	0.186	0.03	(b)
P <sub>2</sub> O <sub>5</sub>						
S %						
sum						
Sc ppm		9.24	9.25	12.4	3.06	(a)
V						
Cr		716			389	(a)
Co		22	54	22		(a)
Ni		190	290	1000	386	(a)
Cu		17.8				(a)
Zn		50				(a)
Ga						
Ge ppb						
As						
Se						
Rb						
Sr						
Y						
Zr						
Nb						
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb						
Cd ppb						
In ppb						
Sn ppb						
Sb ppb						
Te ppb						
Cs ppm						
Ba		226		66		(a)
La	17.6	14.87	18.1	5.46		(a)
Ce		47		15.8		(a)
Pr						
Nd						
Sm		6.9		2.5		(a)
Eu		1.31		0.88		(a)
Gd						
Tb		1.19		0.46		(a)
Dy						
Ho						
Er						
Tm						
Yb		4.6		1.77		(a)
Lu	0.776	0.64	0.82	0.24		(a)
Hf		4.46		1.69		(a)
Ta		0.66		0.19		(a)
W ppb						
Re ppb						
Os ppb						
Ir ppb		20				(a)
Pt ppb						
Au ppb			18			(a)
Th ppm		2.06		1.38		(a)
U ppm		0.81		0.33		(a)

technique: (a) INAA, (b) broad beam e. probe

## References 61500

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